Electromagnetic Compatibility Test Report

Tests Performed on a Grayhill, Inc.

Industrial Handheld Computer, Model DuraMaxH

Radiometrics Document RP-5867

ACCREDITED
Certification # 1495.01

Product Detail:
FCC ID: **NMAM1YY1021**
Industry Canada ID: **2972A-M1YY1021**
Equipment type: 2.4 GHz Spread Spectrum Transmitter

Test Standards:
US CFR Title 47, Chapter I, FCC Part 15 Subpart C
FCC Part 15 CFR Title 47: 2006
Industry Canada RSS-210, Issue 6 as required for Category I Equipment

This report concerns: Original Grant for Certification
FCC Part 15.247

Tests Performed For:	*Test Facility:*
Grayhill, Inc. 561 Hillgrove Rd. LaGrange, IL 60525	**Radiometrics Midwest Corporation** 12 East Devonwood Romeoville, IL 60446

Test Date(s): (Month-Day-Year)
June 30, July 6, and November 3, 2006

Document RP-5867 Revisions:

Rev.	Issue Date	Affected Pages	Revised By
0	November 14, 2006		
1	December 5, 2006	1, 12, 17, 21	Joseph Strzelecki

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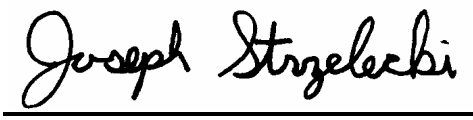
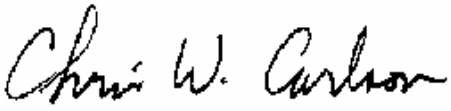
1 ADMINISTRATIVE DATA

Equipment Under Test: A Grayhill, Inc., Industrial Handheld Computer Model: DuraMaxH Serial Number: none This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year) June 30, 2006	*Test Date(s): (Month-Day-Year)* June 30, July 6, and November 3, 2006
Test Report Written By: Joseph Strzelecki Senior EMC Engineer	*Test Witnessed By:* Robert Chiocca Grayhill, Inc.
Radiometrics' Personnel Responsible for Test:  Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE Ron Lazarowicz EMC Engineer	*Test Report Approved By*  Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is an Industrial Handheld Computer, Model DuraMaxH, manufactured by Grayhill, Inc.. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
Unintentional RF Radiated Emissions	30-2,000 MHz	RSS-210 & FCC Part 15	Pass
Conducted Emissions, AC Mains	0.15 - 30 MHz	RSS-210 & FCC Part 15	Pass

Bluetooth FHSS Spread Spectrum Transmitter Requirements

Environmental Phenomena	Frequency Range	FCC Section	RSS-210 Section	Test Result
Carrier Frequency Separation	2400 to 2483 MHz	15.247 a	6.2.2 (o) (a)	Pass
Number of Hopping Frequencies	2400 to 2483 MHz	15.247 a	6.2.2 (o) (a)	Pass
Time of Occupancy (Dwell Time)	2400 to 2483 MHz	15.247 a	6.2.2 (o) (a)	Pass
20 dB Bandwidth Test	2400 to 2483 MHz	15.247 a	6.2.2 (o) (a)	Pass
Peak Output Power	2400 to 2483 MHz	15.247 b	6.2.2 (o) (a)	Pass
Band-edge Compliance of RF Conducted Emissions	2400 to 2483 MHz	15.247 d	6.2.2 (o) (e)	Pass
Spurious RF Conducted Emissions	30 MHz to 25 GHz	15.247 d	6.2.2 (o) (e1)	Pass

Environmental Phenomena	Frequency Range	FCC Section	RSS-210 Section	Test Result
Spurious Radiated Emissions	30 MHz to 25 GHz	15.247 d	6.2.2 (o) (a)	Pass

802.11 DTS Spread Spectrum Transmitter Requirements

Environmental Phenomena	Frequency Range	FCC Section	RSS-210 Section	Test Result
6 & 20 dB Bandwidth Test;	2400 to 2483 MHz	15.247 a	6.2.2 (o) (a)	Pass
Peak Output Power	2400 to 2483 MHz	15.247 b	6.2.2 (o) (a)	Pass
Band-edge Compliance of RF Conducted Emissions	2400 to 2483 MHz	15.247 d	6.2.2 (o) (e)	Pass
Spurious RF Conducted Emissions	30 MHz to 25 GHz	15.247 d	6.2.2 (o) (e1)	Pass
Spurious Radiated Emissions	30 MHz to 25 GHz	15.247 d	6.2.2 (o) (a)	Pass
Power Spectral Density	2400 to 2483 MHz	15.247 e	6.2.2 (o) (b)	Pass

2.1 RF Exposure Compliance Requirements

Since the power output is 21 mW EIRP, The EUT meets the FCC and IC requirements for RF exposure. There are no power level adjustments and the antennas are permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is an Industrial Handheld Computer, Model DuraMaxH, manufactured by Grayhill, Inc. The EUT was in good working condition during the tests, with no known defects. The EUT has two transmitters, an 802.11b WiFi and a Bluetooth.

3.2 Related Submittals

Grayhill, Inc. is not submitting any other products simultaneously for equipment authorization related to the EUT.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

Power was supplied at 115 VAC, 60 Hz single-phase to its external power supply.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Industrial Handheld Computer	E	Grayhill, Inc.	DuraMaxH	None
2	AC Adaptor	E	Ault, Inc.	PW128RA1503F01	None
3	Notebook PC	P	Dell	PPX	28310531 4024706
4	ITE Power supply	P	Dell	09364UC/O CN Rev A00	09364U-16291-275-01WZ
5	Mouse	P	Logitech	M-BT96a	HCA51701289

* Type: E = EUT, P = Peripheral

List of System Cables

QTY	Length (m)	Cable Description	Connected to (Item #)	Shielded?
1	1.9	AC Cord; Power input	#2,	No
3	1.1	Multi-use Cable: The cable is connected to the AC adapter. It also has a USB Active Sync and USB Host Cable	#1 and #2	Yes

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2006	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-2003	2003	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
IC RSS-210 Issue 6	2005	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-212 Issue 1	1999	Test Methods For Radio Equipment
IC RSS-Gen Issue 1	2005	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)
FCC DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
FCC 558074	2005	Measurement of Digital Transmission Systems Operating under Section 15.247

The test procedures used are in accordance with the FCC DA 00-705, <or> FCC 558074, Industry Canada RSS-212 and ANSI document C63.4-2003, "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 1999 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber B: Is a shielded enclosure that measures 24' L X 12' W X 8' H. Erik A. Lindgren & Associates of Chicago, Illinois manufactured the enclosure.

Chamber C: Is a shielded enclosure that measures 20' L X 10' W X 8' H. Lindgren RF Enclosures Inc. of Addison, Illinois manufactured the enclosure.

Chamber D: Is a fully anechoic chamber that measures 22' L X 10' W X 10' H. The walls, ceiling and floor are fully lined with ferrite absorber tiles. Braden Shielding Systems of Tulsa, Oklahoma manufactured the chamber.

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

Open Area Test Site (OATS): Is located on 8625 Helmar Road in Newark, Illinois, USA and measures 56' L X 24' W X 17' H. The entire open field test site has a metal ground screen. The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as file number IC3124.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

9 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	12/22/05
AMP-12	MITEQ	Pre-amplifier	AM-1431	530935	0.01-1000MHz	12 Mo.	02/06/06
AMP-16	MITEQ	Pre-amplifier	AM-1300	608852	0.01-1000MHz	12 Mo.	12/22/05
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo	12/22/05
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	12/21/05
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	10/13/04
ANT-42	EMCO	Bicon Antenna	3104C	9512-4713	25-300MHz	24 Mo.	01/26/06
ANT-44	Impossible Machine	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	12/12/05
ATT-02	KDI	Attenuator	A710N	RMC1	DC-10GHz	24 Mo.	04/20/05
ATT-03	KDI	Attenuator	A710N	RMC3	DC-10GHz	24 Mo.	04/20/05
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	04/20/05
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	04/25/05
LSN-03	Farnell	50 uH LISN	1EXLSN30B	000314	0.01-30MHz	24 Mo.	04/25/05
PRE-01	Hewlett Packard	Preselector	85685A	2510A00143	20 Hz-2GHz	N/A	07/05/06
REC-07	Anritsu	Spectrum Analyzer	MS2601A	MT53067	0.01-2200MHz	12 Mo.	02/07/06
REC-08	Hewlett Packard	Spectrum Analyzer	8566B	2648A13481 2209A01436	30Hz-22GHz	12 Mo.	07/05/06
THM-01	Extech Inst.	Temp/Humid Meter	4465CF	001106557	N/A	24 Mo.	03/31/06

Note: All calibrated equipment is subject to periodic checks.

10 TEST SECTIONS

10.1 AC Conducted Emissions; Section 15.207

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on semi-log graph paper generated by the computer and plotter. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

Broadband conducted emissions may exceed the following limits by no more than 13 dB. An emission is defined as broadband if the average detector amplitude is 6 dB or more under the quasi-peak detector amplitude.

FCC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBuV)	
	Quasi-Peak	Average
0.150 - 0.50*	66 - 56	56 - 46
0.5 – 5.0	56	46
5.0 - 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from power cord, after testing all modes of operation both Bluetooth and 802.11.

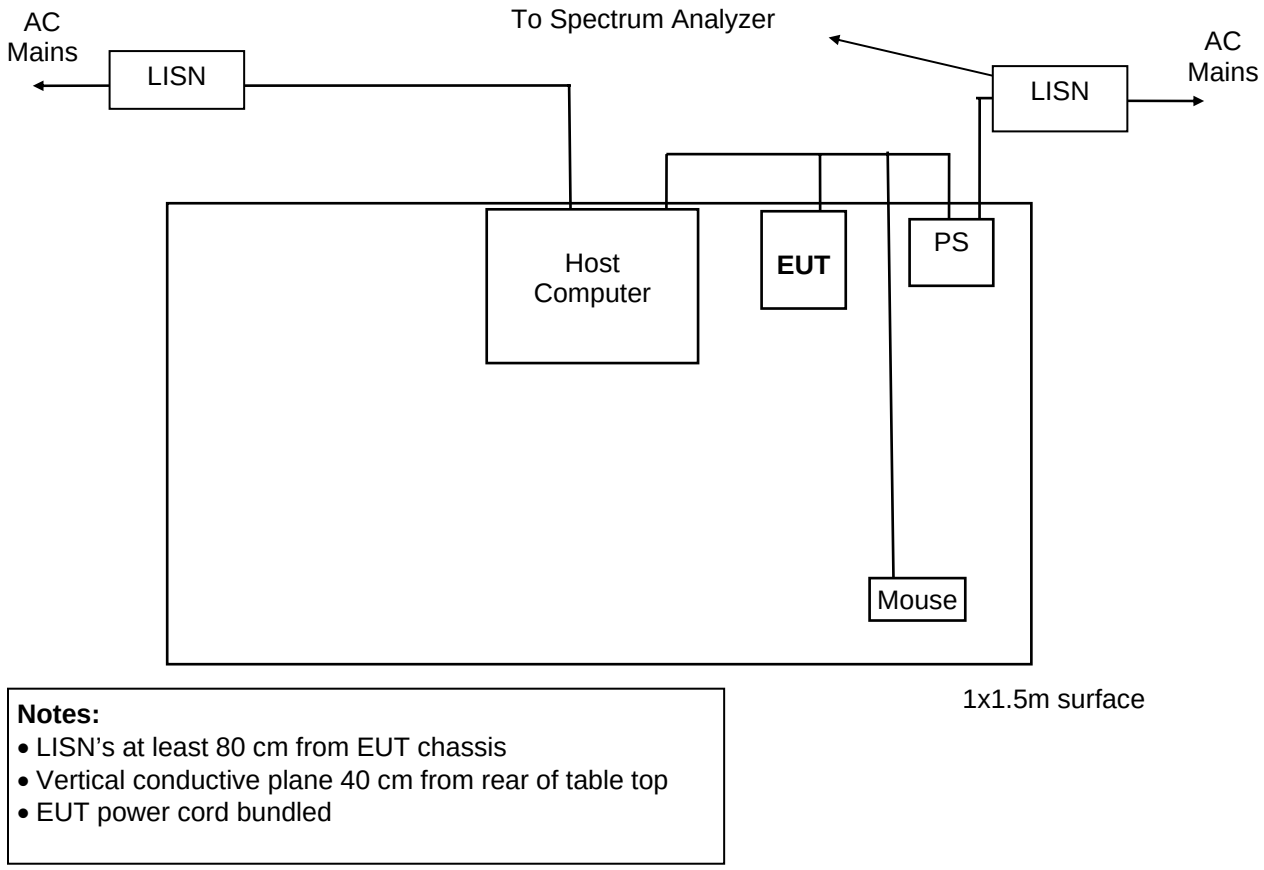
Test Date : November 3, 2006
The Amplitude is the final corrected value with cable and LISN Loss.

Lead Tested	Frequency MHz	QP Amplitude	QP Limit	Average Amplitude	Average Limit
AC Neutral	0.20	51.30	63.63	39.61	53.63
AC Neutral	0.27	45.34	61.25	36.65	51.25
AC Neutral	0.33	39.39	59.40	30.81	49.40
AC Neutral	0.53	44.83	56.00	40.84	46.00
AC Neutral	0.60	44.75	56.00	42.59	46.00
AC Neutral	10.01	32.22	60.00	27.94	50.00
AC Neutral	18.57	29.28	60.00	23.11	50.00
AC Hot	0.20	50.00	63.63	39.72	53.63
AC Hot	0.27	44.22	61.25	37.02	51.25
AC Hot	0.46	37.09	56.62	32.36	46.62
AC Hot	0.53	42.73	56.00	39.18	46.00
AC Hot	0.60	43.15	56.00	41.35	46.00
AC Hot	3.98	33.58	56.00	31.67	46.00
AC Hot	7.09	31.94	60.00	28.48	50.00

* QP readings are quasi-peak with a 9 kHz bandwidth.

Judgment: Passed by 3.41 dB

Figure 1. Conducted Emissions Test Setup

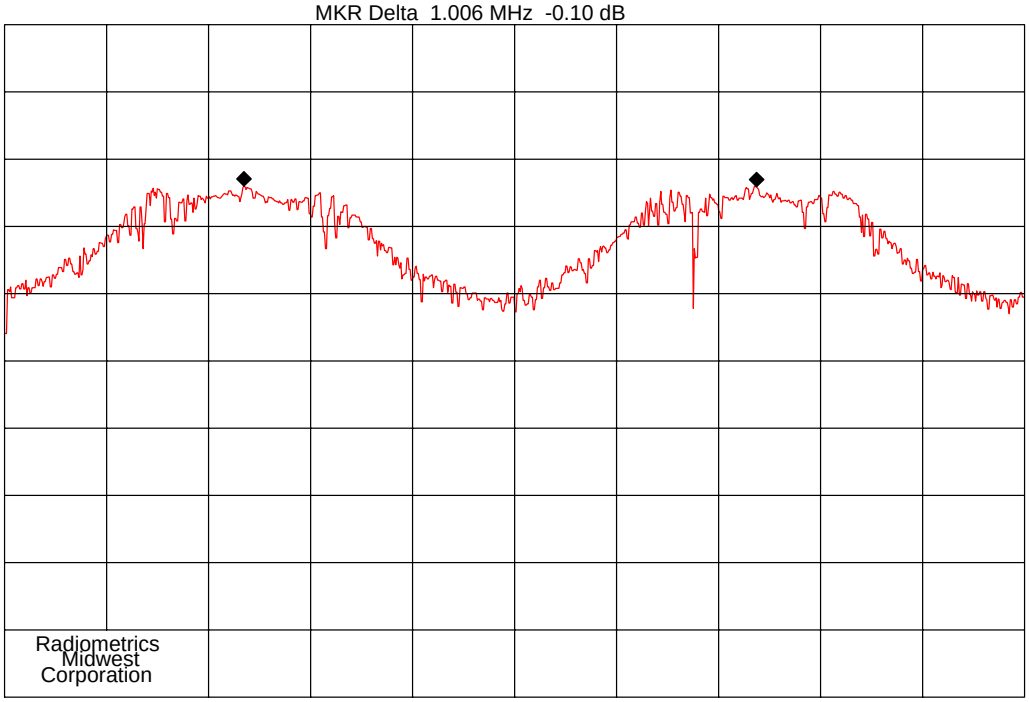


Notes:
- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of table top
- EUT power cord bundled

10.2 Carrier Frequency Separation (Bluetooth)

The channel separation is 1 MHz for this bluetooth device. The minimum separation required is 0.66 MHz since the power is less than 0.125 Watts.

MKR Delta 1.006 MHz -0.10 dB

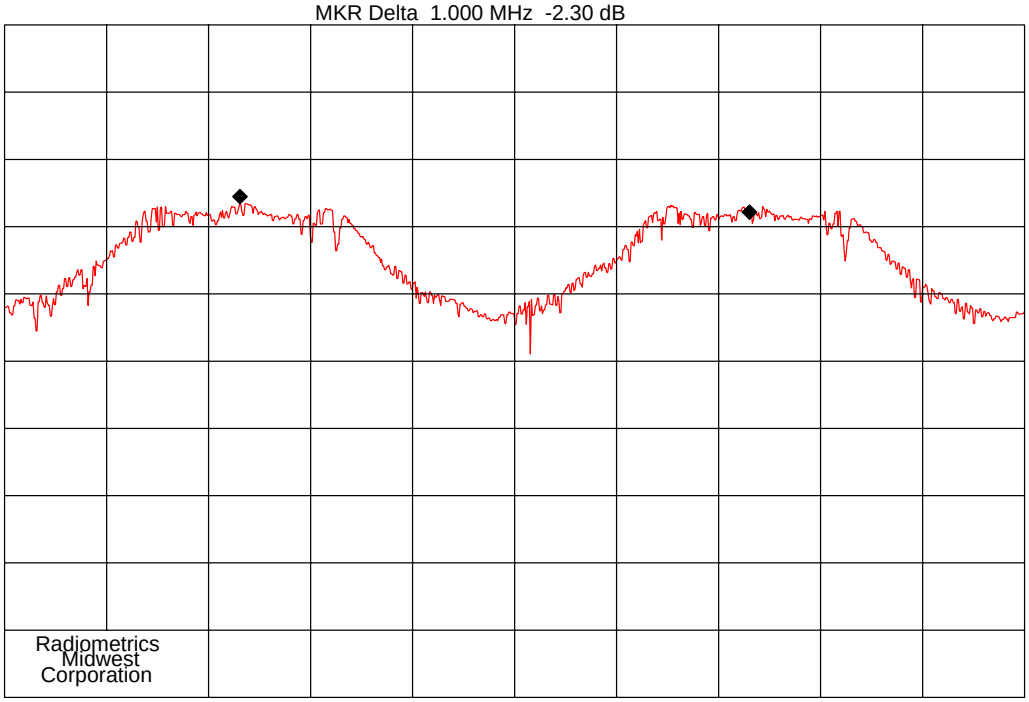


COMPANY : Grayhill
CENTER 2.402 50 GHz
RES BW 100 kHz
10 dB/
NOTES : Carrier Freq Seperation, Bluetooth Low Channel

ITEM : DuraMaxH
REF -20.0 dBm
VBW 300 kHz
TIME : 16:32

DATE : 11-03-2006
SPAN 2.00 MHz
ATTEN 0 dB
SWP 20.0 msec
cf-bt1

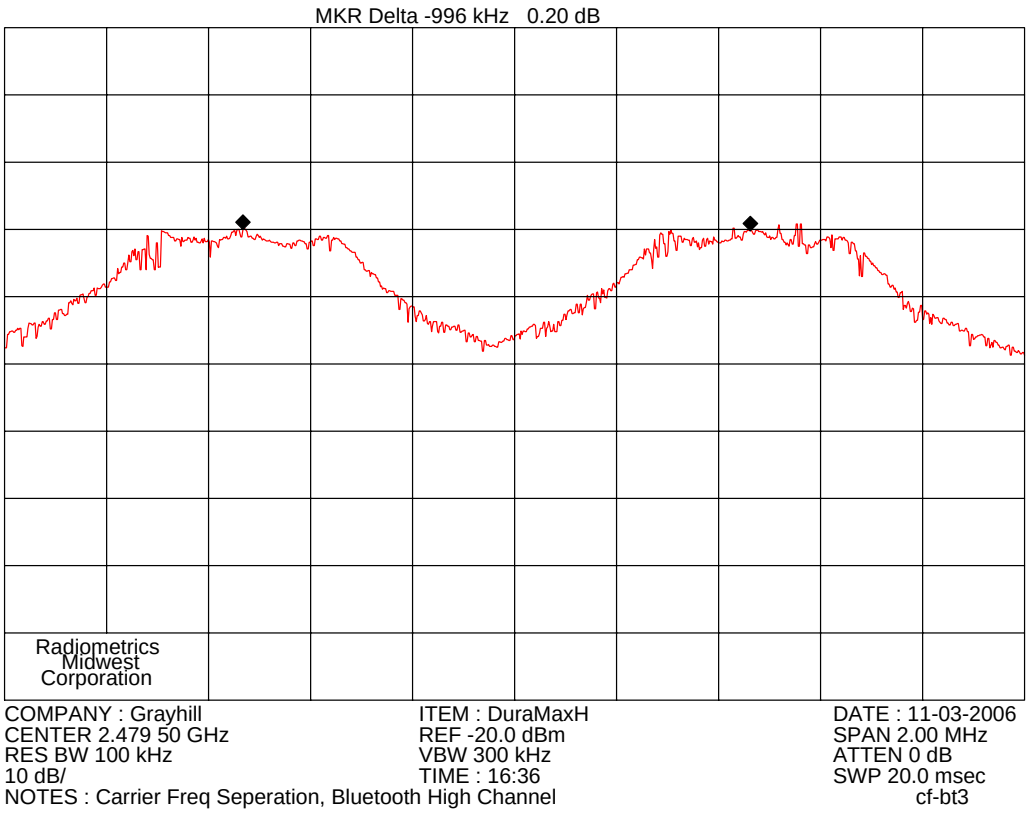
MKR Delta 1.000 MHz -2.30 dB



COMPANY : Grayhill
CENTER 2.440 50 GHz
RES BW 100 kHz
10 dB/
NOTES : Carrier Freq Separation, Bluetooth

ITEM : DuraMaxH
REF -20.0 dBm
VBW 300 kHz
TIME : 16:30

DATE : 11-03-2006
SPAN 2.00 MHz
ATTEN 0 dB
SWP 20.0 msec
cf-bt2



10.3 Number of Hopping Frequencies (Bluetooth)

There are 79 hopping frequencies from 2402 -2480 MHz.

10.4 Time of Occupancy (Dwell Time for Bluetoth)

The dwell time of 0.3797s within a 30 second period in data mode is independent from the packet type (packet length). The calculation for a 30 second period is a follows:
Dwell time = time slot length * hop rate/number of hopping channels *30s
Example for a packet (with a maximum length of one time slot)
Dwell time = 625 us* 1600 1/s/79 * 30s = 0.3797s (in a 30s period)

Slot Length	Hopping Rate per 30 Sec	Number of Channels	Time period of Calculation	Dwell Time in a 30 Sec period	Dwell per 100 mS	PKA (dB)
625 uS	1600	79	30 Sec	0.379747 Sec	3.797 mSec	28.4

PKA = peak to average factor in dB.

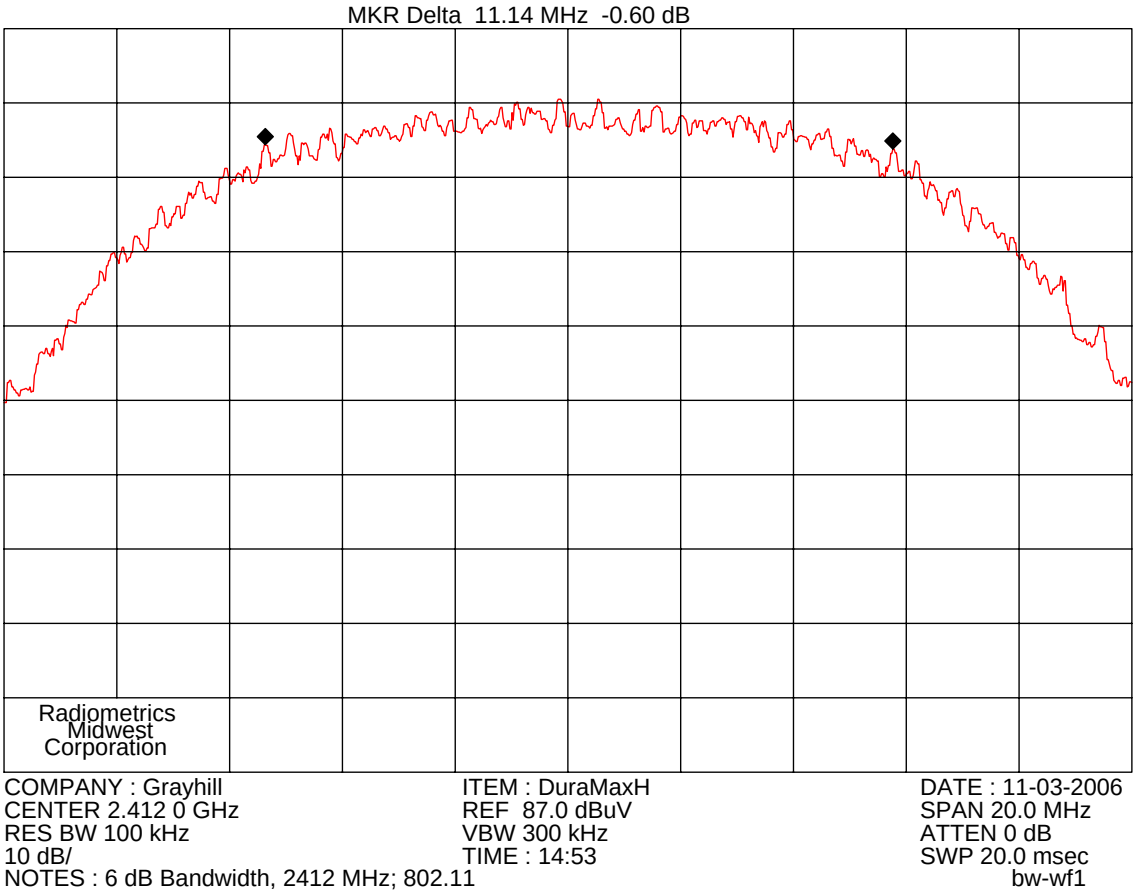
The Peak to average factor is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20 * Log(Duty cycle/100).

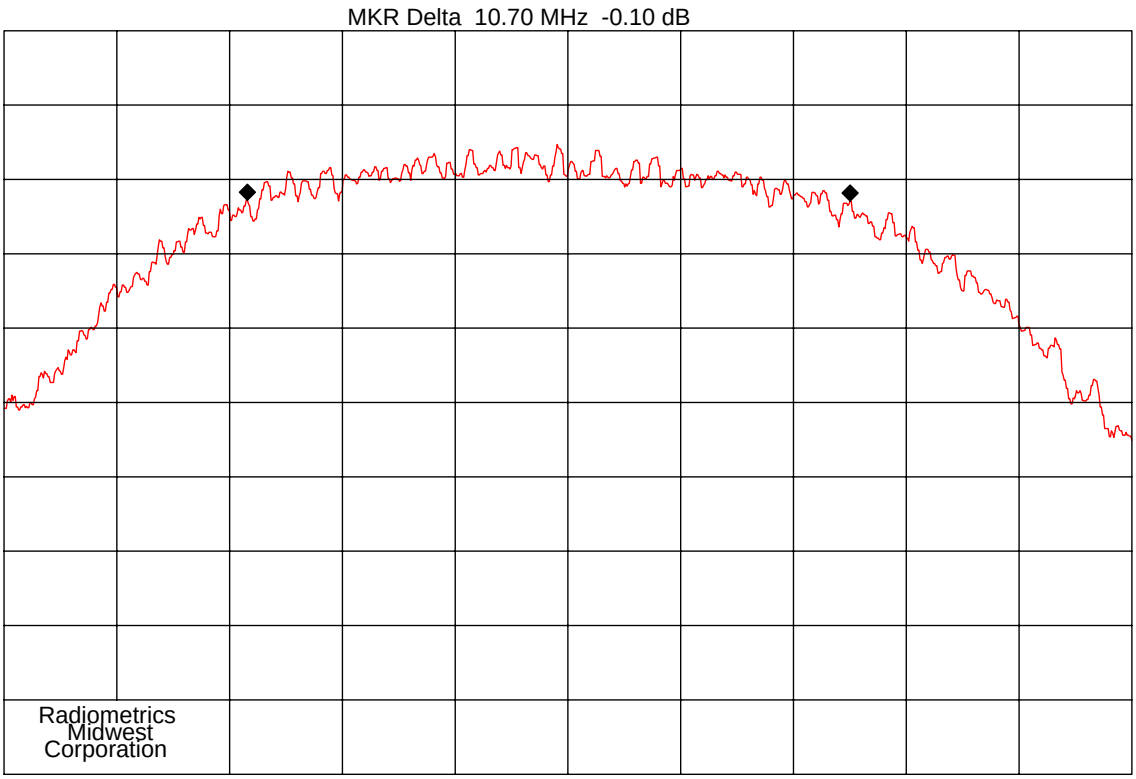
10.5 Occupied Bandwidth (802.11)

Channel	802.11b 6 dB EBW MHz	802.11b 20 dB EBW MHz
1	11.14	14.82
6	10.70	14.79
11	11.22	14.63

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize.

The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

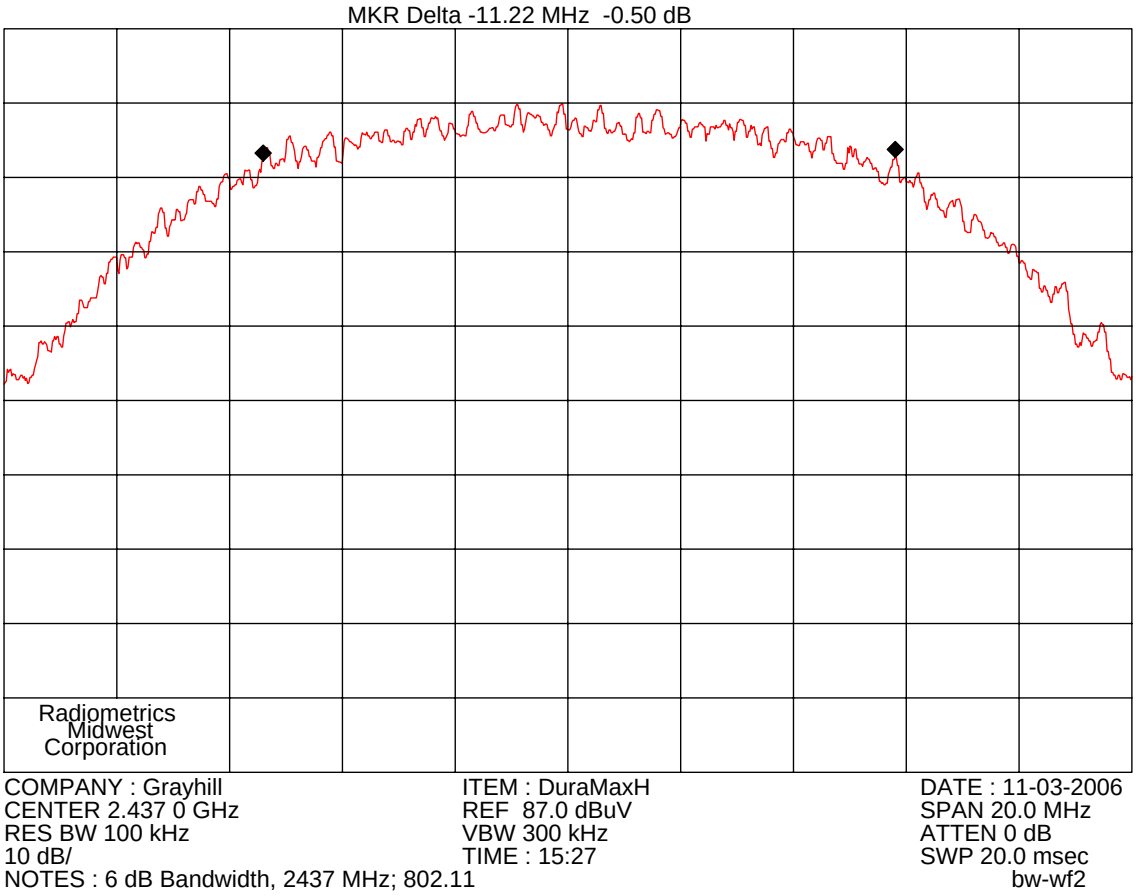




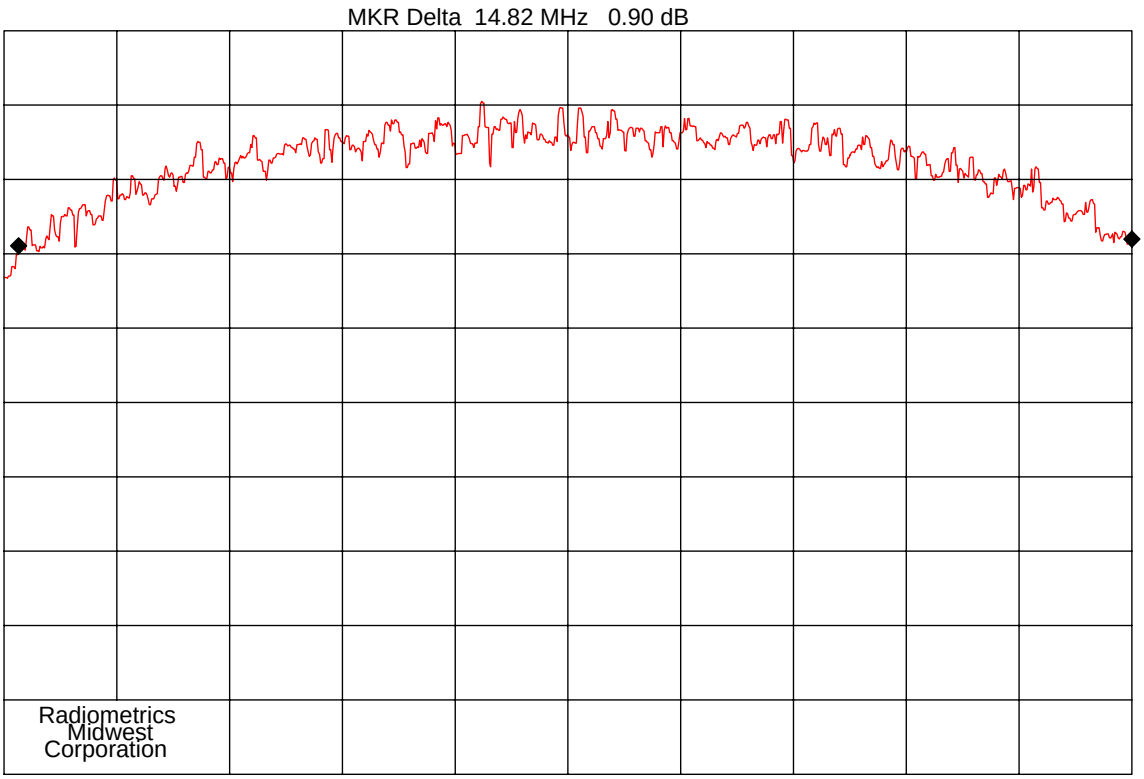
COMPANY : Grayhill
CENTER 2.462 0 GHz
RES BW 100 kHz
10 dB/
NOTES : 6 dB Bandwidth, 2462 MHz; 802.11

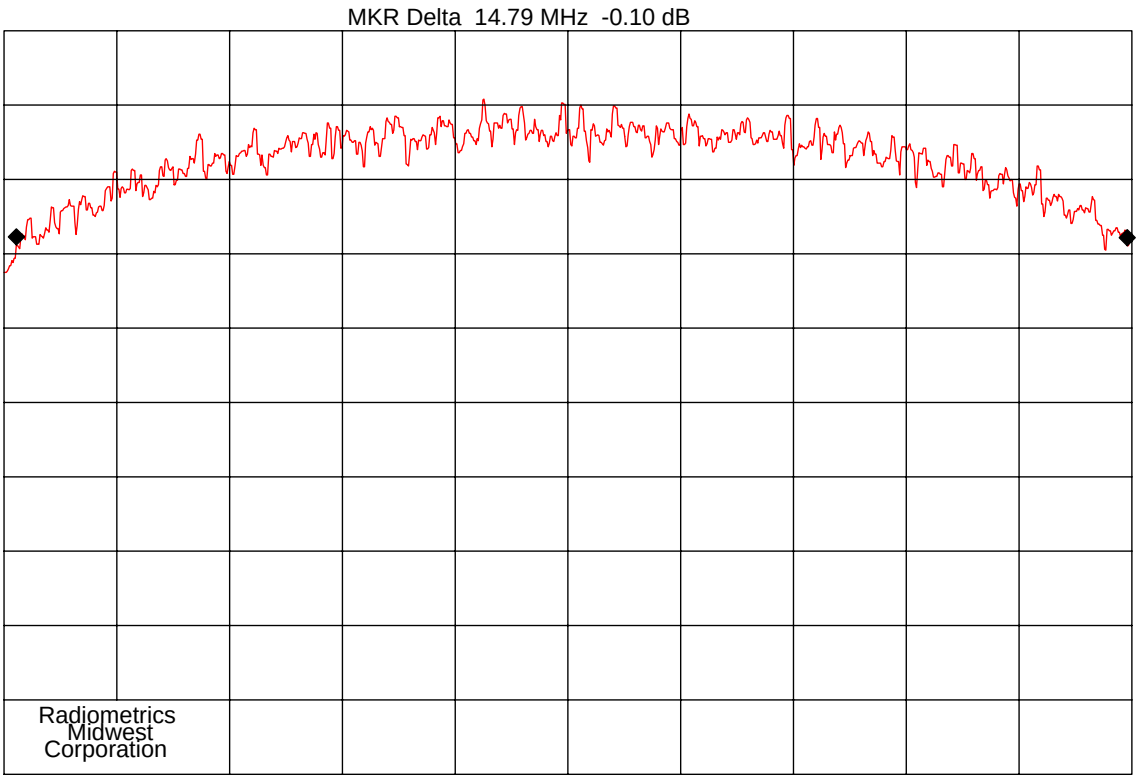
ITEM : DuraMaxH
REF 87.0 dBuV
VBW 300 kHz
TIME : 15:32

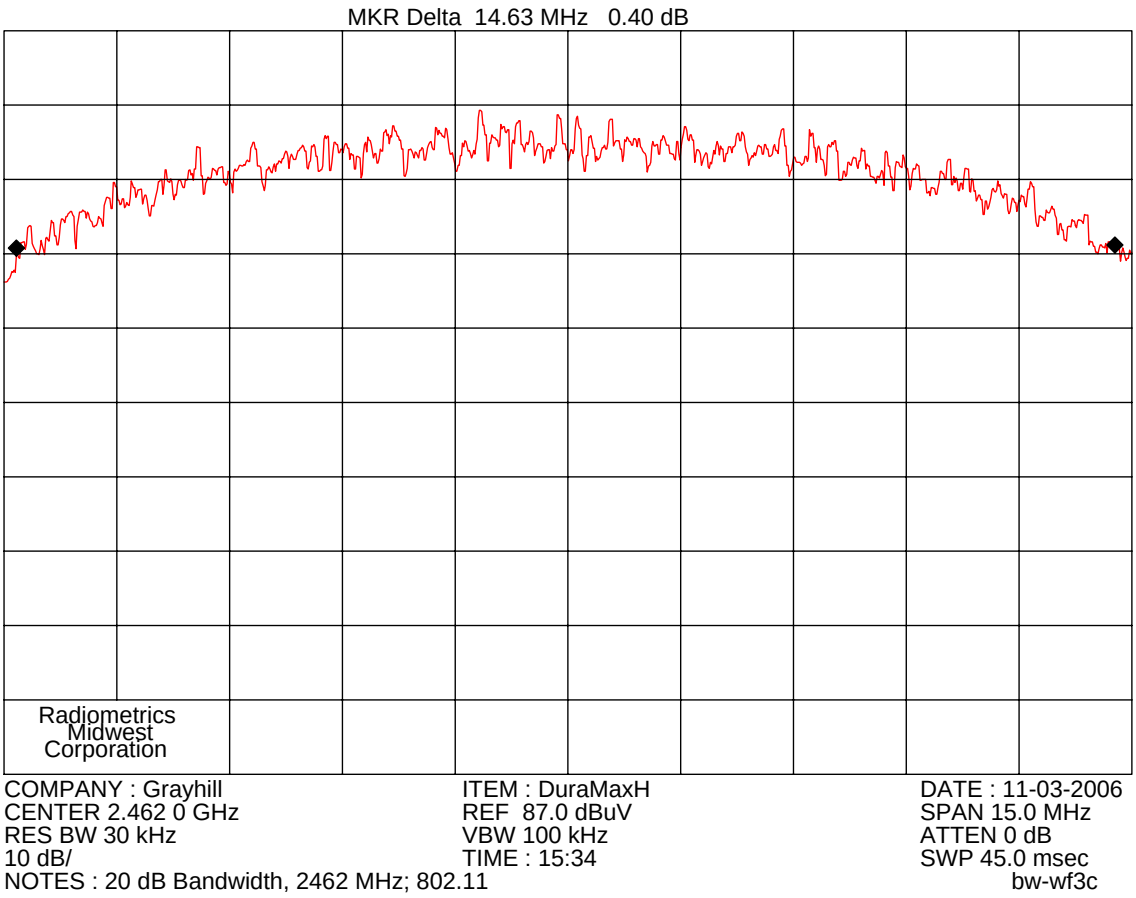
DATE : 11-03-2006
SPAN 20.0 MHz
ATTEN 0 dB
SWP 20.0 msec
bw-wf3



The following shows the 20 dB bandwidth as required by Industry Canada.

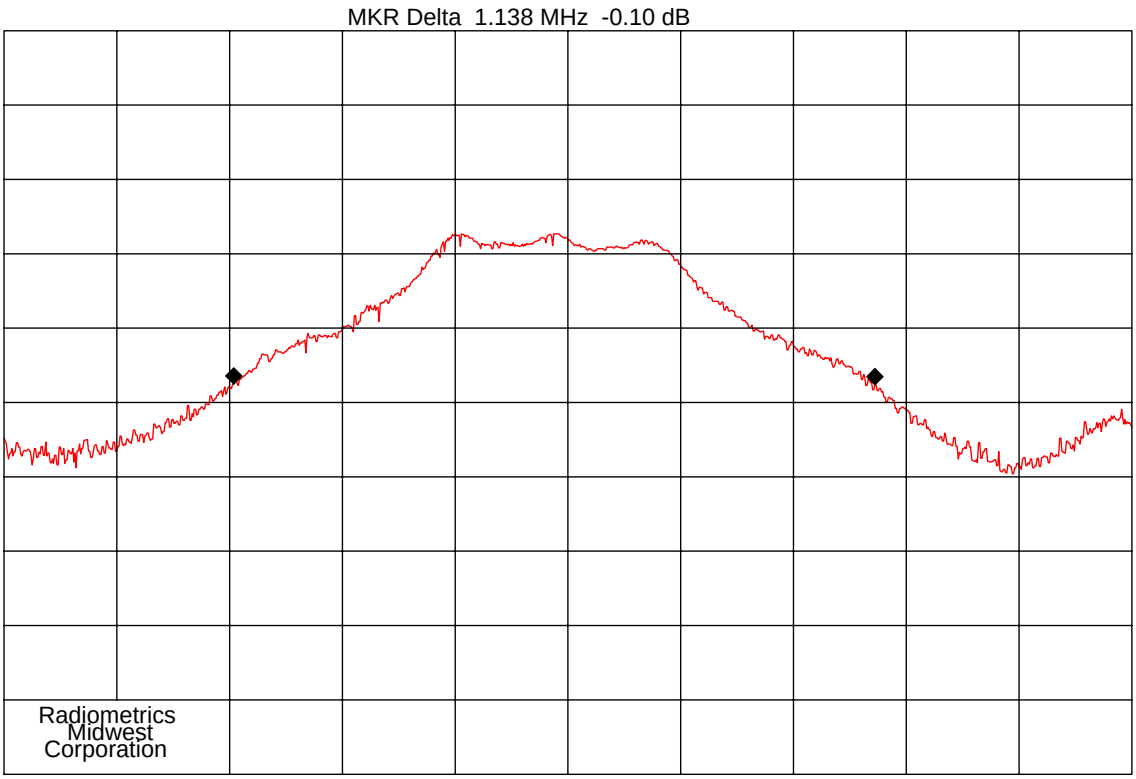

MKR Delta 14.82 MHz 0.90 dB
Radiometrics
Midwest
Corporation
COMPANY : Grayhill
CENTER 2.412 0 GHz
RES BW 30 kHz
10 dB/
NOTES : 20 dB Bandwidth, 2412 MHz; 802.11
ITEM : DuraMaxH
REF 87.0 dBuV
VBW 100 kHz
TIME : 15:37
DATE : 11-03-2006
SPAN 15.0 MHz
ATTEN 0 dB
SWP 45.0 msec
bw-wf1c


MKR Delta 14.79 MHz -0.10 dB
Radiometrics
Midwest
Corporation
COMPANY : Grayhill
CENTER 2.437 0 GHz
RES BW 30 kHz
10 dB/
NOTES : 20 dB Bandwidth, 2437 MHz; 802.11
ITEM : DuraMaxH
REF 87.0 dBuV
VBW 100 kHz
TIME : 15:36
DATE : 11-03-2006
SPAN 15.0 MHz
ATTEN 0 dB
SWP 45.0 msec
bw-wf2c



10.6 Occupied Bandwidth (Bluetooth)

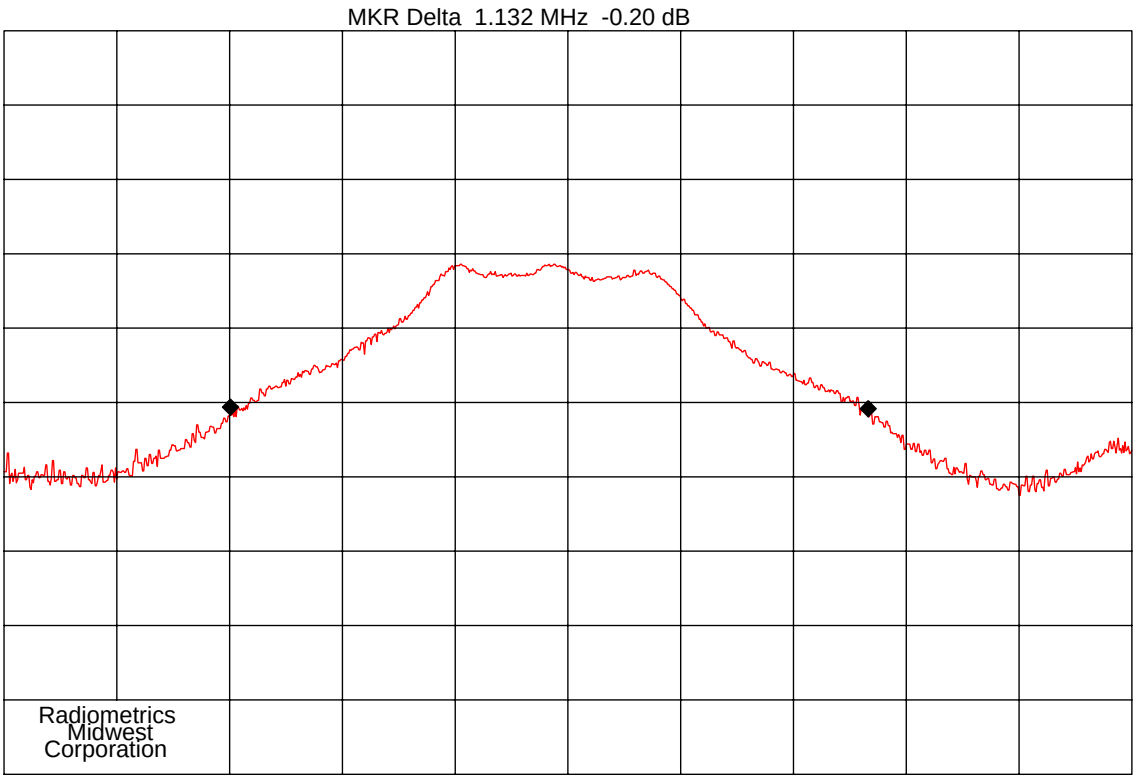
Channel	20 dB EBW MHz
2402	1.138
2441	1.132
2480	1.118



COMPANY : Grayhill
CENTER 2.402 00 GHz
RES BW 100 kHz
10 dB/
NOTES : 20 dB Bandwidth, 2402 MHz Bluetooth

ITEM : DuraMaxH
REF 87.0 dBuV
VBW 300 kHz
TIME : 14:23

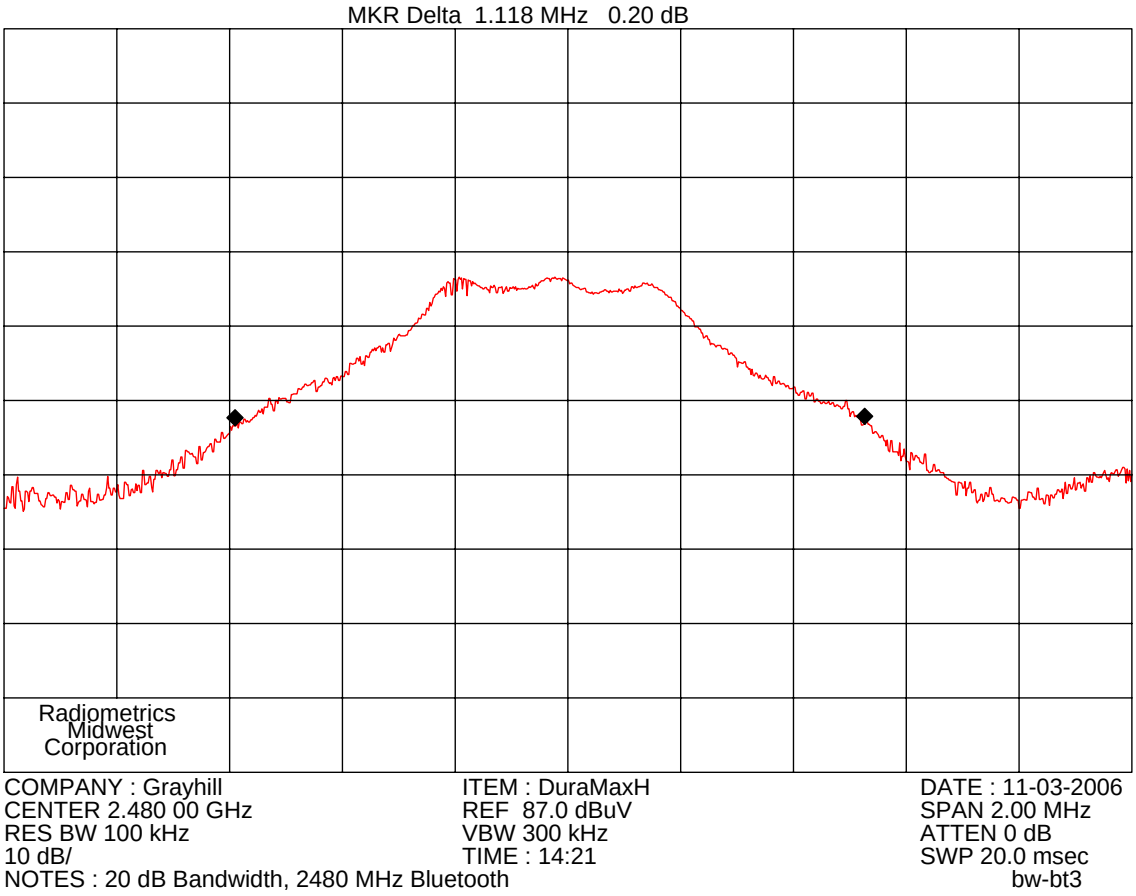
DATE : 11-03-2006
SPAN 2.00 MHz
ATTEN 0 dB
SWP 20.0 msec
bw-bt1a



COMPANY : Grayhill
CENTER 2.441 00 GHz
RES BW 100 kHz
10 dB/
NOTES : 20 dB Bandwidth, 2441 MHz Bluetooth

ITEM : DuraMaxH
REF 87.0 dBuV
VBW 300 kHz
TIME : 14:24

DATE : 11-03-2006
SPAN 2.00 MHz
ATTEN 0 dB
SWP 20.0 msec
bw-bt2a



10.7 Peak Output Power

10.7.1 Output Power (802.11 & Bluetooth)

Since antenna conducted tests cannot be performed on the EUT, radiated tests were performed to show compliance with this requirement. For the 802.11 transmitter, the FCC procedures from power output option 2, Method #3 were used.

The transmitter's peak power was calculated using the following equation:

P = (E x d)^2 / (30 x G)

Where: E = the measured maximum peak field strength in V/m.
G = The numeric gain of the transmitting antenna over an isotropic radiator.
d = Distance in meters from which the field strength was measured. (3 meters)
P = The EUT power in watts

The Field Strength was measured using the procedures described in section 10.9, with the exception of the resolution and video bandwidths. The spectrum analyzer was set to the following settings:

Span = 3 MHz ; RBW = 3 MHz (> the 20 dB bandwidth of the emission being measured)
VBW = 3 MHz; Sweep = auto; Detector function = peak; Trace = max hold

Since the gain of the antenna is always less than 6dB, the limit is not reduced.

Function	Freq	Peak Field Strength		Ant gain	Test Dist.	BW Corr.	Peak Output power from EUT		Limit
	MHz	dBuV/m	V/m	Numeric	Meters	dB	Watts	dBm	dBm
Bluetooth	2402	91.2	0.0363	1	3	0.0	0.00040	-4.0	30
Bluetooth	2441	90.5	0.0335	1	3	0.0	0.00034	-4.7	30
Bluetooth	2480	90.4	0.0331	1	3	0.0	0.00033	-4.8	30
802.11	2412	108.4	0.2630	1	3	10.5	0.23287	23.7	30
802.11	2437	107.7	0.2427	1	3	10.3	0.18929	22.8	30
802.11	2462	108.1	0.2541	1	3	10.5	0.21733	23.4	30

Overall Test result: Pass by 6.33 dB

10.8 Power Spectral Density (802.11)

Since antenna conducted tests cannot be performed on the EUT, radiated tests were performed to show compliance with this requirement. The FCC procedures from PSD option 1 was used. The power spectral density was measured as follows.

The field strength was measured using the procedures described in section 10.9, with the following exceptions: The analyzer was tuned to the highest point of the maximized fundamental emission. The analyzer was set to RBW = 3 kHz, VBW > RBW, span = 300 kHz and a sweep = 100 Sec. Using this peak level, the transmitter's power spectral density was calculated using the following equation:

P = (E x d)^2 / (30 x G)

Where: E = the measured maximum peak field strength in V/m, using the bandwiths in this section.
G = The numeric gain of the transmitting antenna over an isotropic radiator.
d = Distance in meters from which the field strength was measured. (3 meters)
P = The EUT power in watts

EUT	Freq	3kHz PSD Field Strength		Ant gain	Test Distance	3 kHz Spectral Density from EUT		Limit
	MHz	dBuV/m	V/m	Numeric	Meters	Watts	dBm	dBm
802.11	2412	88.4	0.02630	1	3	0.00021	-6.8	8
802.11	2437	87.7	0.02427	1	3	0.00018	-7.5	8
802.11	2462	88.1	0.02541	1	3	0.00019	-7.1	8

Overall Test result: Pass by 14.8 dB

10.9 Spurious RF Conducted Emissions

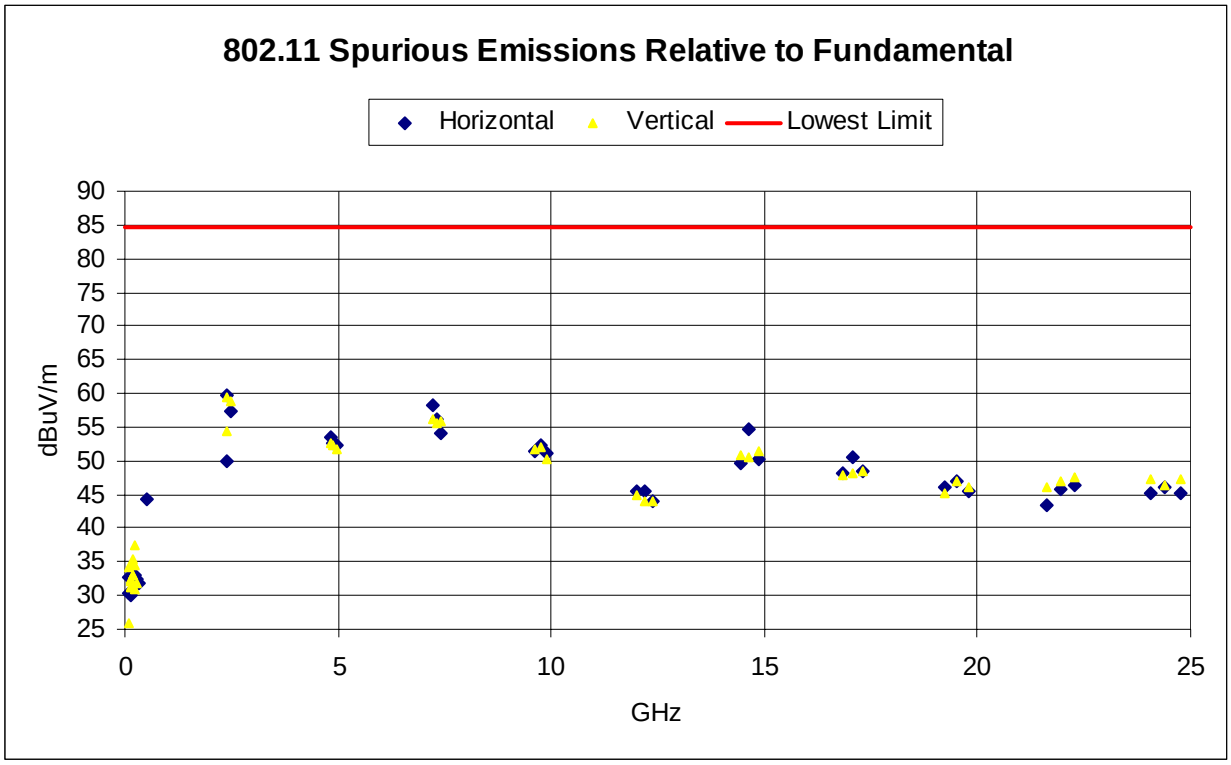
Antenna conducted tests were not performed on the EUT, since the RF connector on the EUT is not standard. Radiated tests were performed to show compliance with this requirement.

The EUT was tested in continous mode and peak readings were made from the lowest frequency generated in the EUT up through the 10th harmonic. The limit is 20 dB lower than the peak of the fundamental. For each polarization and fundamental frequency, there is a separate limit. The data is shown graphically and in tabular form.

10.9.1 Spurious RF Conducted Emissions (802.11)

Since antenna conducted tests cannot be performed on the EUT, radiated tests were performed to show compliance with this requirement.

The 802.11 was tested in continous mode and peak readings were made from the lowest frequency generated in the EUT up through the 10th harmonic. The red limit is 20 dB lower than the lowest peak reading of the fundamental.

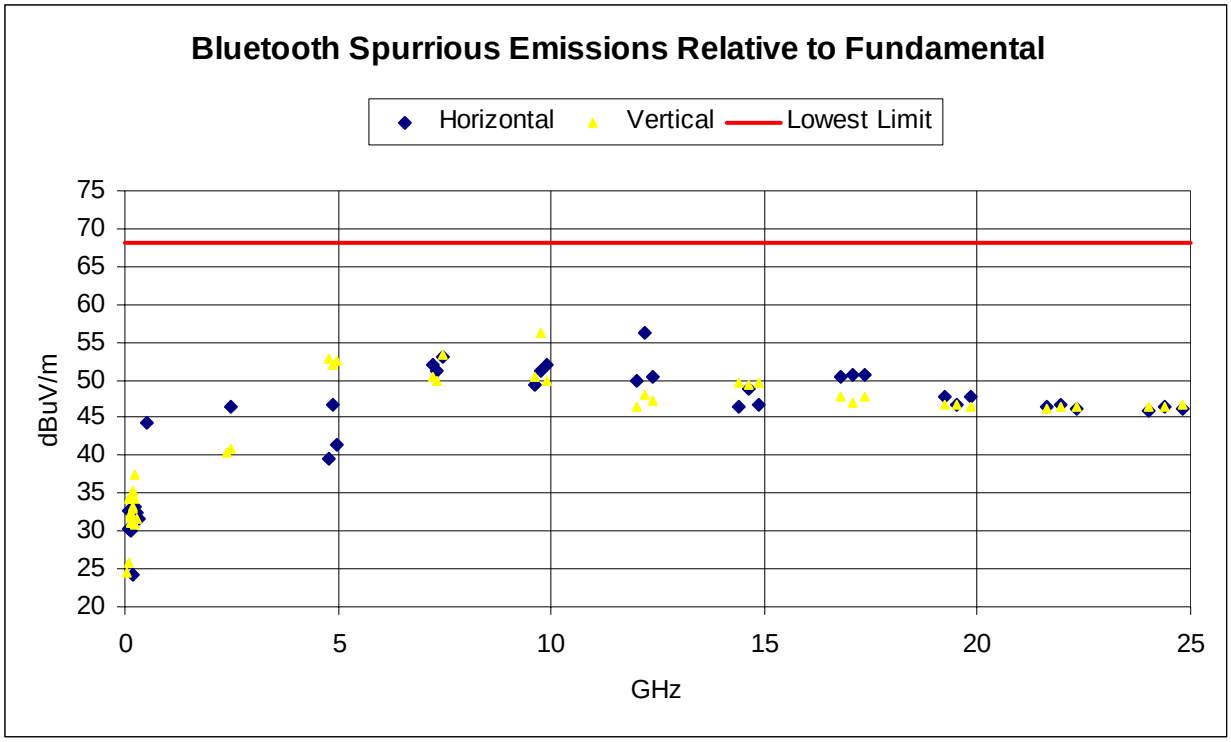


Judgement: Pass by 25.2 dB

10.9.2 Spurious RF Conducted Emissions (Bluetooth)

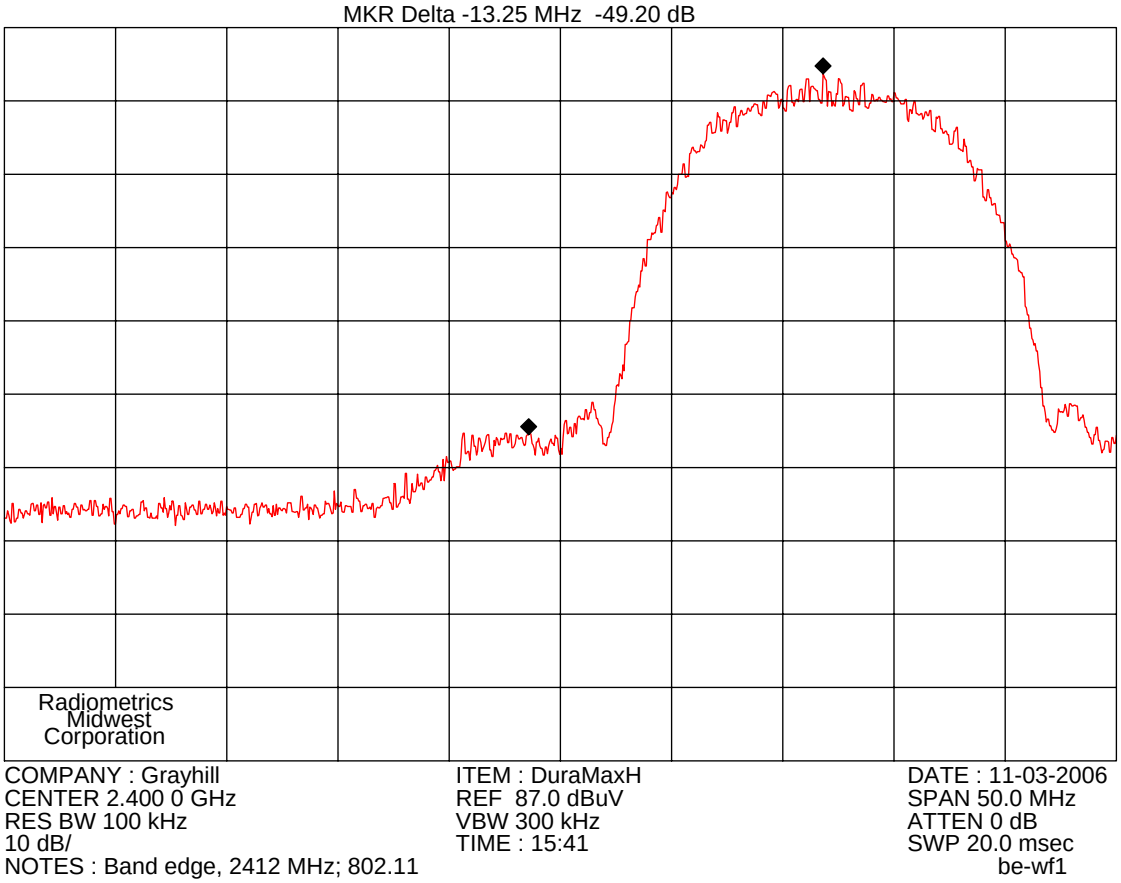
Since antenna conducted tests cannot be performed on the EUT, radiated tests were performed to show compliance with this requirement.

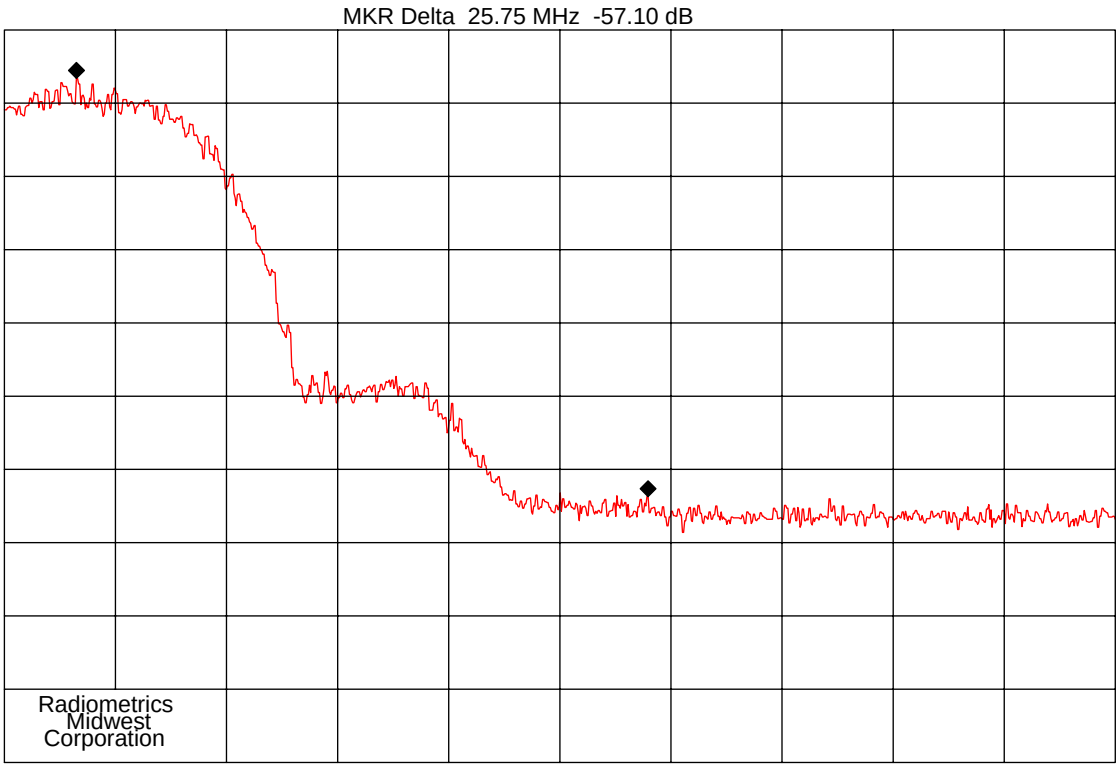
The Bluetooth was tested in continous mode and peak readings were made from the lowest frequency generated in the EUT up through the 10th harmonic. The red limit is 20 dB lower than the lowest peak reading of the fundamental.



Judgement: Pass by 11.8 dB

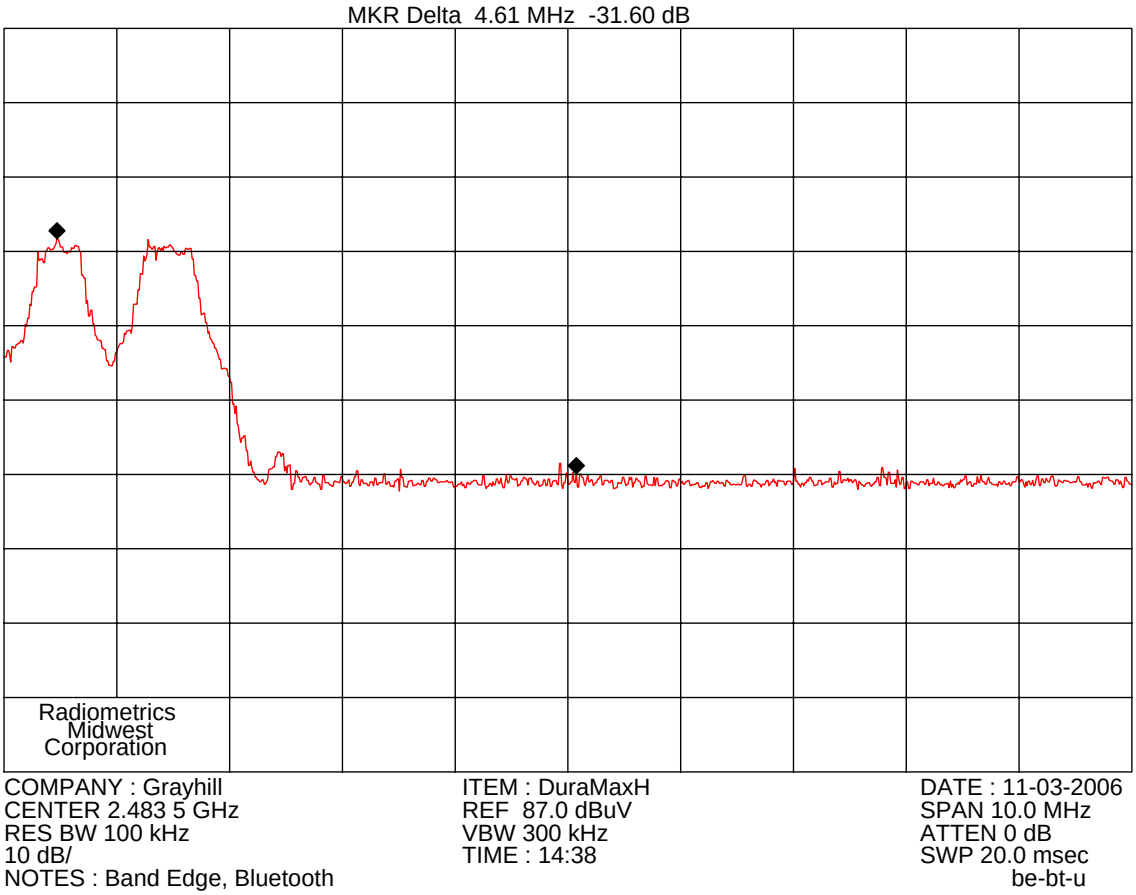
10.9.3 Band edge emissions (802.11)

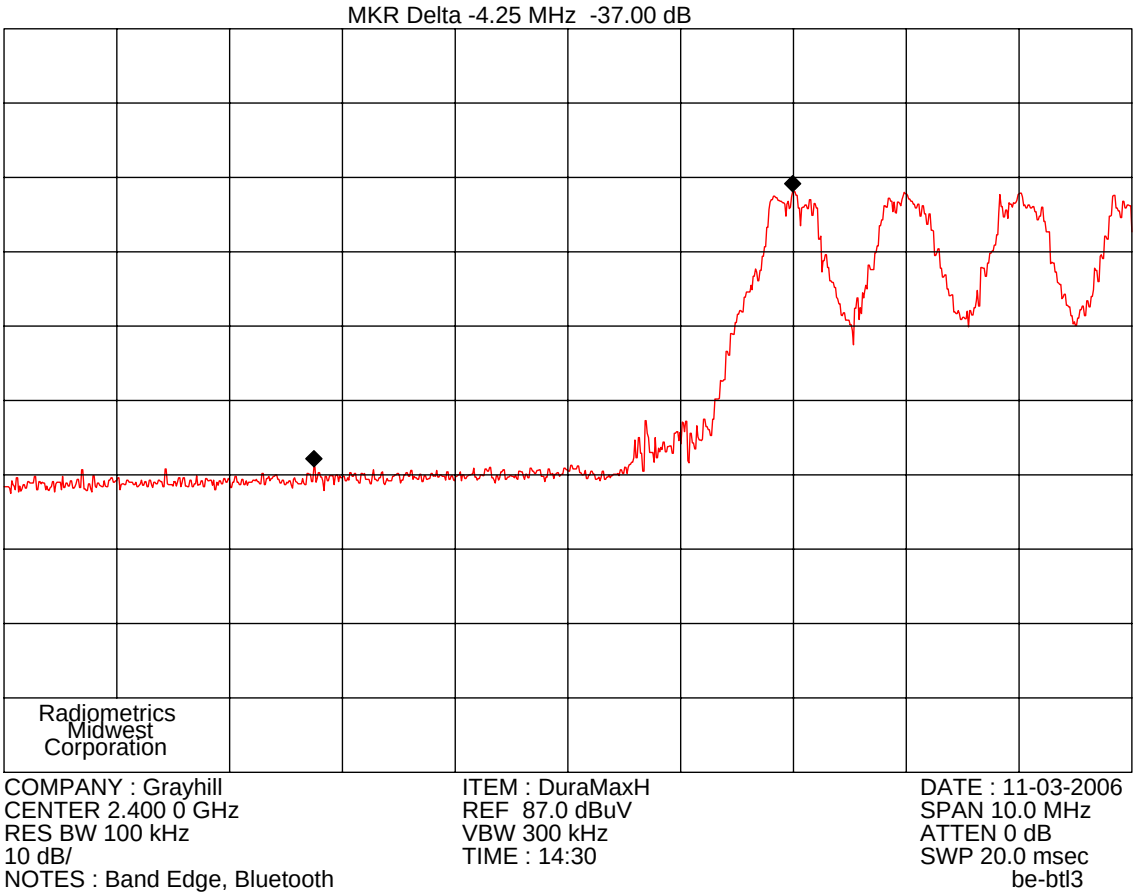




Judgement: pass by 29.2 dB

10.9.4 Band edge emissions (Bluetooth)





Judgement: pass by 11.6 dB

10.10 Spurious Radiated Emissions

Radiated emission measurements in the restricted bands were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. Below 1 GHz, when a radiated emission is detected approaching the specification limit, the measurement of the emission is repeated using a tuned dipole antenna with a Roberts Balun. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 1000 MHz, an Anritsu spectrum analyzer and a preamplifier were used. The out of band emissions and the ambient emissions were below the level of input overload (80 dBuV).

For tests from 1 to 25 GHz, an HP8566A spectrum analyzer was used with a preamplifier. A harmonic mixer was used from 20 to 25 GHz. The out of band emissions and the ambient emissions were below the level of input overload (72 dBuV). In addition, a high pass filter was used to reduce the fundamental emission.

Radiated emission measurements are performed with linearly polarized broadband antennas. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded.

Final radiated emissions measurements were performed in Chamber E at a test distance of 3 meters. The entire frequency range from 30 MHz to 25 GHz was slowly scanned and the emissions in the restricted frequency bands were recorded. Measurements were performed using the peak detector function. The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground. The anechoic test chamber has a metal ground screen.

The was device was rotated through three orthogonal axis as per 13.1.4.1 of ANSI C63.4 during the prescans and during final radiated tests.

10.10.1 Radiated Emissions Field Strength Sample Calculation

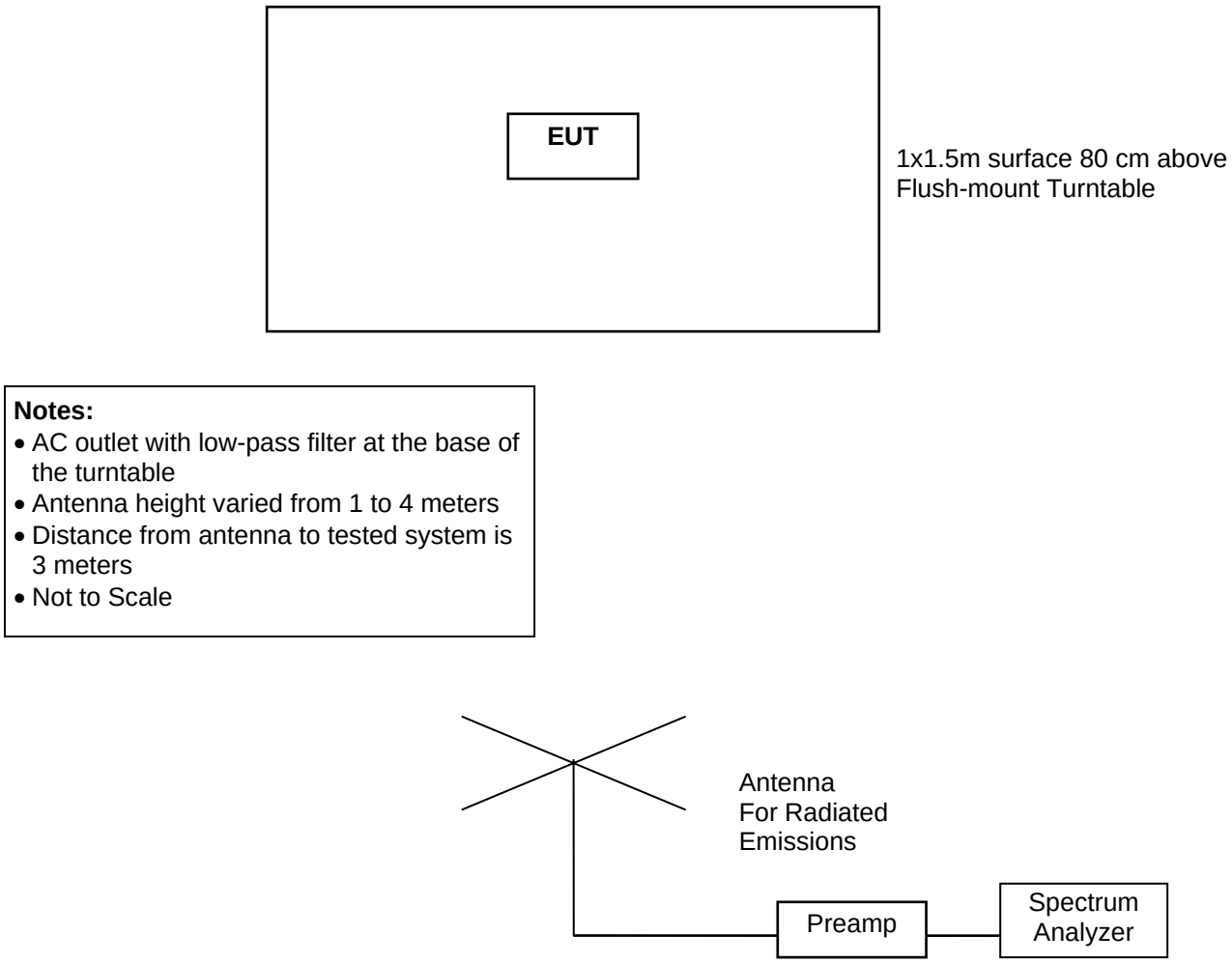
The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + CF - AG

Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
HPF = High pass Filter Loss
PKA = Peak to Average Factor (This is used for Bluetooth Average measurements only. All other measurements, it was zero)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20 * Log(Duty cycle/100).

Figure 2. Drawing of Radiated Emissions Setup



10.10.2 Spurious Radiated emissions results above 2 GHz

10.10.2.1 Spurious Radiated Emissions Test Results (802.11)

The following spectrum analyzer settings were used.
Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
A Video Bandwidth of 10 Hz was used for Average measurements.

hrm #	Tx Freq	Ant Pol.	802.11b Peak Analyzer RDG dBuV	802.11b Ave Analyzer RDG dBuV	Corr. Fact. dB	EUT Emission Freq MHz	Field Strength from EUT Peak dBuV/m	Field Strength from EUT Ave dBuV/m	Field Strength Limit Peak dBuV/m	Field Strength Limit Ave dBuV/m	Margin Under Limit dB
1	2412	V	98.0	85.0	10.4	2412	108.4	95.4	125.0	105.0	9.6
1	2412	H	95.6	84.3	10.4	2412	106.0	94.7	125.0	105.0	10.3
be	2412	V	44.1	35.0	10.4	2389	54.5	45.4	74.0	54.0	8.6
be	2412	H	39.4	31.2	10.4	2390	49.8	41.6	74.0	54.0	12.4
2	2412	V	39.5	32.0	13.4	4824	52.9	45.4	74.0	54.0	8.6
2	2412	H	40.2	32.1	13.4	4824	53.6	45.5	74.0	54.0	8.5
3	2412	V	36.9	26.0	19.4	7236	56.3	45.4	74.0	54.0	8.6
3	2412	H	38.9	27.5	19.4	7236	58.3	46.9	74.0	54.0	7.1
1	2437	V	97.2	86.7	10.5	2437	107.7	97.2	125.0	105.0	7.8
1	2437	H	94.3	86.3	10.5	2437	104.8	96.8	125.0	105.0	8.2
2	2437	V	39.0	28.2	13.4	4874	52.4	41.6	74.0	54.0	12.4
2	2437	H	39.5	30.7	13.4	4874	52.9	44.1	74.0	54.0	9.9
3	2437	V	36.2	26.8	19.5	7311	55.7	46.3	74.0	54.0	7.7
3	2437	H	36.8	27.1	19.5	7311	56.3	46.6	74.0	54.0	7.4
1	2462	V	97.3	85.5	10.8	2462	108.1	96.3	125.0	105.0	8.7
1	2462	H	96.3	86.0	10.8	2462	107.1	96.8	125.0	105.0	8.2
be	2462	V	48.1	40.5	10.9	2483.5	59.0	51.4	74.0	54.0	2.6
be	2462	H	46.5	38.7	10.9	2483.5	57.4	49.6	74.0	54.0	4.4
2	2462	V	38.0	31.5	13.7	4924	51.7	45.2	74.0	54.0	8.8
2	2462	H	38.6	31.8	13.7	4924	52.3	45.5	74.0	54.0	8.5
3	2462	V	35.5	26.7	19.7	7386	55.2	46.4	74.0	54.0	7.6
3	2462	H	33.7	24.0	19.7	7386	53.4	43.7	74.0	54.0	10.3

* Noise Floor of analyzer; No detectable emission

Notes: 1. hrm = Harmonic; BE = Band Edge emissions; V = Vertical; H = Horizontal
2. The margin (last column) is the worst case margin under the peak or average limits for that row.
3. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor

Judgment: Passed by 2.6 dB
No other emissions were detected in the restricted bands from 2 to 25 GHz.

10.10.2.2 Spurious Radiated Emissions Test Results (Bluetooth)

hrm #	Tx Freq	Ant. Pol.	Analyzer RDG dBuV Peak	Analyzer RDG dBuV Average	Corr. Fact. dB	EUT Emission Freq MHz	Field Strength (dBuV/m) Peak Total	Field Strength (dBuV/m) Ave Total	Field Strength (dBuV/m) Peak Limit	Field Strength (dBuV/m) Ave Limit	Margin Under Limit dB
be	2402	V	35.1	6.7	5.3	2390	40.4	12.0	74	54	33.6
be	2402	H	34.2	5.8	5.3	2390	39.5	11.1	74	54	34.5
2	2402	V	40.4	12.0	12.3	4804	52.7	24.3	74	54	21.3
2	2402	H	39.7	11.3	12.3	4804	52	23.6	74	54	22.0
3	2402	V	35.1	6.7	15.3	7206	50.4	22.0	74	54	23.6
3	2402	H	34	5.6	15.3	7206	49.3	20.9	74	54	24.7
2	2441	V	39.7	11.3	12.3	4882	52	23.6	74	54	22.0

hrm #	Tx Freq	Ant. Pol.	Analyzer RDG dBuV		Corr. Fact. dB	EUT Emission Freq MHz	Field Strength (dBuV/m)				Margin Under Limit dB
			Peak	Average			Peak Total	Ave Total	Peak Limit	Ave Limit	
2	2441	H	38.9	10.5	12.3	4882	51.2	22.8	74	54	22.8
3	2441	V	34.2	5.8	15.7	7323	49.9	21.5	74	54	24.1
3	2441	H	35.6	7.2	15.7	7323	51.3	22.9	74	54	22.7
be	2480	V	35.1	6.7	5.7	2483.5	40.8	12.4	74	54	33.2
be	2480	H	35.6	7.2	5.7	2483.5	41.3	12.9	74	54	32.7
2	2480	V	39.8	11.4	12.8	4960	52.6	24.2	74	54	21.4
2	2480	H	40.2	11.8	12.8	4960	53	24.6	74	54	21.0
3	2480	V	36.7	8.3	16.5	7440	53.2	24.8	74	54	20.8
3	2480	H	35.5	7.1	16.5	7440	52	23.6	74	54	22.0

Notes: 1. hrm = Harmonic; BE = Band Edge emissions; V = Vertical; H = Horizontal
2. The margin (last column) is the worst case margin under the peak or average limits for that row.
3. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
4. The Average reading is the peak reading – PKA (Peak to average factor) as defined in section 10.4 herein

Judgment: Passed by 20.8 dB
No other emissions were detected in the restricted bands from 2 to 25 GHz.

10.10.3 Spurious Radiated Emissions Below 2 GHz (Bluetooth and 802.11)

Manufacturer	Grayhill, Inc.	Specification	FCC Part 15 Subpart C & RSS-210
Model	DuraMaxH	Test Date	7/6/2006
Serial Number	M1YY1021-2QVGA	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical (ANT-3); LP = Log-Periodic (ANT-6); HN = Horn (ANT-13) P = peak; Q = QP		
Notes	Corr. Factors = Cable Loss – Preamp Gain – Duty Cycle Factor + HP Filter Loss		

The following is the worst case emissions from EUT below 2.3 GHz. The results include intentional and unintentional emissions.

Freq. MHz	Meter Reading dBuV	Antenna Factor dB	Antenna Pol/ Type	Corr. Factors dB	Field Strength dBuV/m EUT	Field Strength dBuV/m Limit	Margin Under Limit dB
72.0	52.8 Q	6.9	H/44	-27.0	32.8	40.0	7.2
74.0	50.7 P	6.6	H/44	-27.0	30.4	40.0	9.6
119.8	41.6 P	14.9	H/44	-26.4	30.1	43.5	13.4
242.4	46.1 P	12.2	H/44	-25.4	33.1	46.0	12.9
288.2	44.3 P	13.0	H/44	-25.1	32.3	46.0	13.7
108.1	48.0 P	12.8	V/44	-26.6	34.3	43.5	9.2
131.6	43.2 P	14.2	V/44	-26.3	31.2	43.5	12.3
137.6	45.7 P	12.8	V/44	-26.3	32.3	43.5	11.2
138.5	44.9 P	12.4	V/44	-26.3	31.2	43.5	12.3
156.3	47.3 P	10.7	V/44	-26.1	32.0	43.5	11.5
168.0	50.5 Q	10.3	V/44	-26.0	34.9	43.5	8.6
173.5	48.8 P	10.1	V/44	-26.0	33.0	43.5	10.5
240.0	50.0 Q	12.8	V/44	-25.4	37.5	46.0	8.5
252.3	43.1 P	12.9	V/44	-25.3	30.8	46.0	15.2
264.4	43.6 P	13.2	V/44	-25.2	31.7	46.0	14.3

Judgment: Passed by 7.2 dB
No other emissions were detected in the restricted bands.